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ABSTRACT

To measure industrial development in Taiwan, four variables were used: the index of industrial production, electricity consumed in kilowatt hours per capita, Gross National Product per capita, and the percentage of the active working force engaged in non-agricultural occupations. The primary objective of the study was to design a predicting model for technical education (preparation of skilled workers at the middle level of the educational system) in relation to industrial growth in the developing country by determining which of the four variables is the best single predictor. Data from 1947 through 1966 were used, allowing for a time lag of one to ten years for educational inputs to have economic impact and to determine which lag period results in the highest correlation. It was determined that the percentage of the working population in non-agricultural occupations is the best single predictor of the number of students in technical education in the lag time of zero year. A regression equation provides the model sought by the study. (AG)

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A PREDICTING MODEL FOR TECHNICAL EDUCATION IN RELATION TO INDUSTRIAL DEVELOPMENT*

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*Presentation made at the 1970 Annual Meeting of American Educational Research Association in Minneapolis, Minnesota, March , 1970.

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Statement of the Problem

Developing regions, seeking to accelerate industrial development through education, are handicapped by a lack of knowledge of the relationship between technical education and industrial development, two components most frequently associated with development. The primary objective of the present study is to design a model which can be used to predict certain requirement for technical education from specific industrial development variables. Such model may be useful in planning for future educational program.

The first step of this study is the search for valid variables or indicators of (A) industrial development, and (B) technical education. This is followed by examining the data which describe these two variables and by computing correlations between variable A and variable B for a period of 20 years from 1947-1966. Thus, we could find out which indicator of industrial development is the best single predictor of technical education. Consequently we design a model which can be used to predict certain requirement for technical education from specific industrial development variable.

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* Presentation made at the 1970 Annual Convention of American Educational Research Association in Minneapolis, Minnesota on March 6, 1970.

VARIABLES

Variable A: Industrial Development

Four indicators are widely used to measure industrial development. The most highly industrialized countries--such as the United States, Japan, Russia and the United Kingdom--in comparison with less industrialized countries, demonstrate high "scores" in industrial production, electricity consumed, per capita GNP and the percentage of the active working force in non-agricultural occupations. These "scores" suggest that these indicators do distinguish among levels of industrial development. Thus, the following four variables will be used to measure industrial development in Taiwan:

1. The Index of Industrial Production. This number is designed to measure changes in the volume of physical production in industry. The index is computed from (a) manufacturing industries, including food, beverages, tobacco, textiles, apparel, wood, paper and paper products, printing, leather, rubber products, coal and petroleum products, non-metallic mineral products, basic metals, metal products, machinery, appliances, transport equipment, and miscellaneous products; (b) mining industries, including coal, metal, crude petroleum and natural gas, salt evaporation, and miscellaneous non-metallic mining and quarrying; (c) building construction industries; and

(d) public utilities. The year 1947 is employed as the fixed based year for making comparisons over time, and consequently the official index has been recalculated to this base year.

2. Electricity consumed in kwh per capita. Electricity consumed provides a convenient, rough, but reasonably accurate estimate of development. It has great advantages for measuring technical development because statistics on electric power consumption are readily available for practically every country in the world in internationally comparable units. The figures are more creditable because few errors are made in computing them. Furthermore, production and consumption figures are for all practical purposes equal. Electric power consumed is especially relevant to industrial development: It is widely used in the public sector for transportation, lighting streets; it is basic to nearly all kinds of manufacturing; yet it is also a consumption item. Measures of electricity consumed continue to be important indicators of industrial development, even in countries at the highest levels of economic development. In short, electricity consumed ought to be a good index of development in countries varying widely in internal economic structures. (This statement is supported by the fact that kwh consumed per capita correlated .86 with estimates of income per

capita in 40 countries in the 1950s.)[1]

3. Gross National Product per capita (in constant U. S. dollars). Like the other indicators, per capita GNP may have some margin of error, but it appears to be one of the best available measures for international comparisons of level of economic development.

4. The percentage of the active working force engaged in non-agricultural occupations. This is a simple but important indicator of the level of economic development. (Active working force is here defined as the age group from 12 to 65.)

Variable B: Technical Education

In order to analyze the relationship between technical education and industrial development, it is necessary to examine technical education variables in absolute numbers of students to determine whether they are increasing significantly in relation to industrial development.

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[1] David C. McClelland, The Achieving Society (Princeton: Van Nostrand, 1961)

Hypothesis to be Tested

As we have indicated, the primary objective of the present study is to design a predicting model for technical education in relation to industrial development in a developing country, Taiwan. To do so, we have tested the following hypotheses, which examine the relationship which exists between the measure of industrial development and the measure of technical education.

1. Of the four indicators of industrial development, the best single predictor of the number of students in technical education at the second level in relation to industrial development is the variable, the percentages of the working population in non-agricultural occupation, in the lag time of zero year.

2. A satisfactory predicting model can be designed which is useful for predicting certain features of technical education from specific industrial development variable.

Methodology - Research Design

As was indicated previously, we are concerned with examining data which will describe each of the variables of the study, to consider the larger context in which these data are to be interpreted. It is appropriate here to consider the techniques which have been used in this analysis.

Data from 1947 through 1966 are used. According to Jacoby,[1] Taiwan, during the past ten years, has been one of the most rapidly developing countries economically in Asia. Moreover, its rate of educational development has also

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1 Neil H. Jacoby, An Evaluation of U.S. Economic Aid to Free China, 1951-1965 (Washington, D.C.: Bureau for the Far East, Agency for International Development, 1966), [Later published as U.S. Aid to Taiwan (New York: Frederk A. Praiger, 1966)].

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been substantial. Taiwan thus provides an excellent country in which to test the hypothesis.

Data

The data used to describe the industrial development and technical education indicators have been drawn primarily from governmental and other documents. Many of these documents, not readily available outside of Taiwan, were examined during the field research phase of this study. In addition to examining documents, the field research had three other important purposes: to interview government officials, educators, teachers, students, industrialists and others involved in industrial development and technical education in Taiwan; to develop and interpret relevant statistics on the spot; and to inspect industries and schools to learn first hand about changes which have recently occurred in Taiwan. Tables of relevant statistical data obtained during the field research are to be found in table I.

Data Analysis

The basic approach to the research has been to calculate correlation coefficients between technical education variables and industrial development variables. It is not likely that increased educational inputs would have an immediate economic impact, although some three to five years later the educated stock will affect the labor force. Some data collected by Kaser[3] suggest that this may be the case. Therefore, we have attempted to examine the data in this study from this point of view. When each measurement is labeled with its year, a function involving two variables may stipulate a time-interval which should separate the year of the mutually associated values of the two variables. Such

[3] M. C. Kaser, "Education and Economic Progress: Experience in Industrialized Market Economics," in E.A.G. Robinson (ed.), The Economics of Education (New York: St. Martin's Press, 1966), pp. 89-173.

TABLE I

Year	1. Index of Industrial Production	2. Electricity Consumed (Per Capita) (kwh)	3. Per Capita GNP (in U.S.dollar) (at constant) (prices of) (of 1963)	4. Percentage of Non-Agr. Occupations (%)	5. Student
1947	100	68	86	32.5	7050
1948	167	75	87	34.2	7607
1949	208	85	91	37.3	8792
1950	227	94	95	37.2	8969
1951	268	124	97.1	37.1	8853
1952	339	132	101.5	37.9	8572
1953	421	145	107.3	37.4	8868
1954	450	160	109.5	39.6	9258
1955	500	165	109.8	40.1	10257
1956	523	189	109.9	40.1	11279
1957	596	215	111.7	41.8	12041
1958	642	241	114.7	43.0	13137
1959	725	266	122.4	43.4	12805
1960	827	291	125.9	43.9	13182
1961	915	316	131.9	44.2	13030
1962	1031	353	135.4	44.7	13142
1963	1135	367	147.9	45.5	13367
1964	1430	423	167.9	45.8	13714
1965	1664	449	172.5	46.3	15152
1966	1915	499	179.3	50.9	17396

Sources:
1. Ministry of Economic Affairs, Taipei, Taiwan.
2. Taiwan Power Company, Ministry of Economic Affairs, Taipei, Taiwan.
3. Directorate-General of Budgets, Account & Statistics, Executive Yuan (1947-1950 was estimated).
4. "Household Registration" of Provincial Department of Civil Affairs, Taichung, Taiwan.
5. Ministry of Education, Taipei, Taiwan
   Provincial Department of Education, Taichung, Taiwan

intervals or lags of various lengths may be interposed between every two variables in the function. Thus, the recorded earlier values of each technical education variable may be associated with the subsequent value of each industrial development variable (see Figure I).

Thus correlations are calculated for the industrial development variable for given years with the technical education variables for preceding years. Lags of one through ten years are used in an effort to determine which lag period results in the highest correlation.

Scope and Limitations

The scope of the present study is limited to an attempt to predict, through the construction of the predicting model, the requirements for technical education in relation to the future growth of industrialization in Taiwan. Although we are concerned with understanding the context in which industrialization in Taiwan has occurred and will occur in the future - including such considerations as market available for industrial products and capital formations - our major interest lies in examining the relationships between human resource training and industrial development. Furthermore, we realize that human resource training, without concomitant consideration of human resource mobilization, does not give a complete picture even of this on aspect of industrialization. Nevertheless, we will examine primarily the development of human resource rather than their recruitment and employment patterns.

The study is also limited in term of human resource training, to concern with formal education rather than on the job training and in terms of technical education, to concern with quantitative analysis of technical education does not present either a complete or a fully accurate picture of the importance of technical education; such analysis does provide sufficient information with

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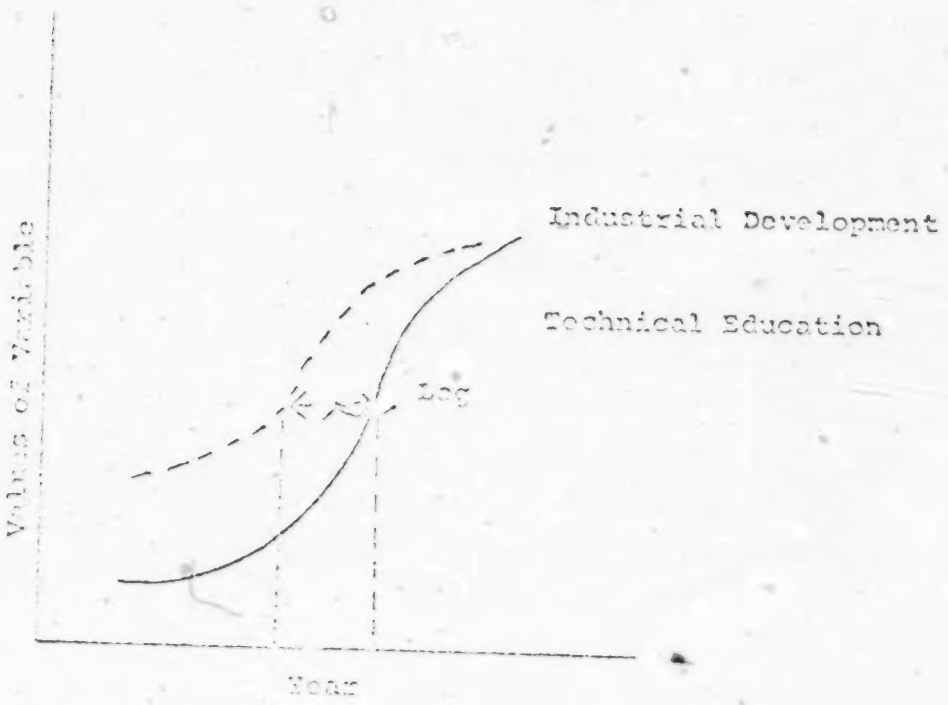
FIGURE 1

An Example of the Recorded Earlier Values of Technical Education Influencing the Subsequent Values of Industrial Development



which to analyze the past, current and future functional relationships between technical education and industrial development.

Finally, as has been pointed out in the preceding pages, we are referring with the use of the term technical education to that education which prepares skilled workers at the middle level of the educational system.

The researcher assumes that there are positive marginal gains at the present level of technical education. That is, it is assumed that as increments of input of technical education, the output of industrial development do not remain content and do not decrease one a certain level of increment is reached.

The research further assumes that there is a linear or nearly linear relationship between technical education and industrial development. That is, it is assumed that the relationship between the two variables is not curvlinear. This is an important assumption in using linear regression equation for prediction.

Results

Hypothesis 1. The percentage of the working population in non-agricultural occupations is the best single predictor of the four industrial development variables employed of the number of students in technical education at the second level.

As is indicated in Table 1, using industrial development as determining variable, the highest correlation for industrial development going from 1947 to 1966 and for technical education going from 1947 to 1966, is the percentage of the working population in non-agricultural occupations in the lag time of zero year (is 0.98). Consequently, we may not reject the hypothesis that the

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TABLE II

THE CORRELATION BETWEEN A, THE VARIABLES OF INDUSTRIAL DEVELOPMENT AND B, TECHNICAL STUDENTS

Variable of 2nd Development	Lag (year) 0	1	2	3	4	5	6	7	8	9	10
A_1 - B	.935	.947	.953	.953	.955	.954	.942	.925	.890	.846	.773
A_2 - B	.936	.930	.945	.955	.939	.932	.931	.929	.914	.883	.826
A_3 - B	.915	.925	.943	.936	.950	.934	.913	.908	.832	.744	.647
A_4 - B	.931	.942	.911	.902	.895	.892	.910	.917	.923	.896	.716

Correlations are all significant at the 1 percent level of confidence

A_1 = the index of industrial development

A_2 = electricity consumed

A_3 = tax per capita GDP

A_4 = the percentage of non-agricultural occupations

percentage of the working population in non-agricultural occupation is the best single predictor of the industrial development variables employed of the worker of students in technical education at the second level.

Hypothesis 2 A satisfactory predicting model can be designed which is useful for predicting certain features of technical education from specific industrial development variable.

As was stated before, the best single predictor of the number of students in technical education is the percentage of the working population in non-agricultural occupations in the lag time of zero year. Furthermore, we know that the mean of the students in technical education at the second level ($\bar{Y}$), from 1947 to 1966 is 11,323.55; and that the mean of the percentage of the working population in non-agricultural occupation ($\bar{X}$), from 1947 to 1966 is 41.145. The slope of the education (B) between the number of students in secondary technical education from 1947 to 1966, and the percentage of the working population in non-agricultural occupations, from 1947 to 1966 is 616.

Therefore, we can establish the following regression equations or a predicting model to predict the number of students in secondary technical education in relation to industrial development.

$Y = \bar{Y} + B(X-\bar{X})$ or

$Y = 11,323.55 + 616\ (X - 41.145)$ or

$Y = 616\ X - 13933$

The way in which these regression equations may be presented graphically should be considered. The predictor variable, which is the variable of industrial development in the present study, is designated as the X variable,

and it is represented along the horizontal axis. In this instance, the horizontal axis represents the percentage of the working population in non-agricultural occupations. (See Figure II)

The predicted variable, which is the variable of technical education in the present study, is designated as the Y variable and is represented along the vertical axis. This variable is represented as the number of technical students.

One see clearly, in examining figure II, that for each value of the predictor variable, the regression equation may be used to determine what the prediction value of the other variable must be. In figure II, for instance, let us suppose that the percentage of the working population in non-agricultural occupations will be 52 percent in 1968, 55 percent in 1969, and 60 percent in 1970. If one locates these three percentages on the horizontal axis, one finds that the corresponding values on the vertical axis are 18,800, 20,000, and 23,200 respectively. Thus, from the percentage of the working population in non-agricultural occupations, one can estimate the number of students in technical education at the second level.

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Figure 11

The Regression Equation for Predicting the Number of Technical Students on the Percentage of the Working Population in Non-agricultural Population is Graphed